

Before the
Federal Communications Commission
Washington DC 20554

In the Matter of)	
)	
Authorization and Use of Software)	ET Docket No. 00-47
Defined Radios)	

COMMENTS OF CLEARWIRE TECHNOLOGIES, INC.

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Clearwire Technologies, Inc. (Clearwire) hereby files these comments in the above-captioned proceeding.¹ Clearwire is a provider of, and manufactures equipment for, two-way wireless high speed Internet access.

With the few exceptions noted below, Clearwire supports the Commission's proposals.

A. Software-defined Radios Are in the Public Interest.

Software-defined radios (SDRs) will bring several advantages to the public:

- ***Spectrum efficiency (1).*** SDRs will enable new, more spectrum-efficient modulations to be deployed quickly. In contrast, upgrading hardware-based radios for spectrum efficiency takes years, sometimes decades, because each generation of equipment must amortize its costs before it can be replaced.
- ***Spectrum efficiency (2).*** SDRs will include adaptive technologies that allow radios to optimize communications between two or more units in real time. This includes features such as adaptive data rate control (to use more efficient modulations when a given channel has a favorable signal-to-noise ratio) and adaptive power control (for better frequency reuse by minimizing interference among radios).
- ***Spectrum efficiency (3).*** A large percentage of licensed spectrum is idle at any one time. The Commission is presently exploring mechanisms to allow both long-term and short-term transfers to maximize use of this

¹ *Authorization and Use of Software Defined Radios*, ET Docket No. 00-47, Notice of Proposed Rule Making, FCC 00-430 (released Dec. 8, 2000) (Notice).

spectrum.² Short-term arrangements will require radios capable of shifting quickly among bands and modulations.

- ***Spectrum efficiency (4):*** SDRs will ultimately eliminate the need for uniform spectrum allocations. They will help to minimize waste by permitting each country, or even parts of a country, to allocate spectrum according to local needs.
- ***Rapid innovation.*** Today, new services generally require the distribution of new equipment, which adds cost and slows availability. SDRs will permit the swift dissemination of new services through software distributed over the air.
- ***Interoperability.*** SDRs will permit both national and global roaming, regardless of differences in local frequency allocations and modulation standards.
- ***Flexible allocations.*** Recent proceedings have asked whether the Commission should relocate or "repack" existing services in the spectrum to make room for new ones.³ This option tends to be impracticably expensive and disruptive with hardware radios, but an installed base of SDRs could make relocation feasible in some cases.

B. Software-defined Radios Are Well Suited to Fixed Applications.

The Commission correctly notes that SDR technology is sufficiently advanced for the consideration of specific rules.⁴ Clearwire expects to install SDRs for fixed applications within the next year, or soon thereafter as rules take effect.

² *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, WT Docket No. 00-230, Notice of Proposed Rulemaking, FCC 00-402 (released Nov. 27, 2000).

³ *E.g., Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems*, ET Docket No. 00-258, Notice of Proposed Rule Making and Order, FCC 00-455 (released Jan. 5, 2001).

⁴ Notice at para. 11.

Even at this early stage, Clearwire expects to validate NTIA's views on the large set of transmitter characteristics susceptible to software control: tuning range, channeling, bandwidth, bit rate, modulation frequency, pre-emphasis, deviation ratio, power, pulse characteristics, and digital-to-analog (D/A) converter update rate.⁵ We expect other parties' predictions on multi-band, multi-mode, and multi-function capabilities will also prove correct.⁶ The advantages of SDRs will include post-manufacture re-programmability, ultimately via over-the-air downloads, and common hardware platforms for manufacturers.⁷

At least at the outset, NTIA may be correct that SDRs will have greater size, weight, and power consumption than a single-function radio implemented in hardware.⁸ But the comparison to a single-function hardware radio is inapt, because the advantage of SDRs lies precisely in their ability to shift frequency range, bandwidth, modulation, etc. as needed. We think it likely that a hardware-based radio as flexible as even a relatively simple SDR would exceed the SDR in size, weight, and power consumption.

The fixed services are an ideal test bed for SDR development, inasmuch as factors such as size, weight, and power consumption will have little impact on performance. We urge the Commission to promulgate at least a minimum set of rules quickly, so that development of fixed equipment can begin the evolution of commercial SDR equipment in all categories.

⁵ Notice at para. 9.

⁶ *Id.*

⁷ *Id.*

⁸ Notice at para. 10.

C. The Commission's Regulatory Proposals Are Well Founded.

1. Testing procedures

Clearwire agrees in principle that hardware and software should be tested together.⁹

However, in comments being filed today, Vanu, Inc, points out that only certain software layers are critical to RF operation, and only those need be tested together with the hardware.

Specifically, Vanu proposes a regulatory distinction between "platform software," which manages critical transmitter functions such as frequency, power, and bandwidth; and "signal-processing software," which embodies the details of the particular modulation in use. The platform software manages the hardware under control of the signal-processing software, and responds to hardware requests from the signal-processing software. The platform software in turn monitors the behavior of the signal-processing software, and turns off the radio if it goes out of compliance. An encrypted software tag, which sets the technical limits for each radio service, adds an extra layer of protection.¹⁰

Vanu shows that separate layers will result in more reliable software. The platform software has a much simpler logic flow than the signal-processing software (or the monolithic software contemplated by the Notice), and so can be more thoroughly tested and debugged. Moreover, because the platform software will support a wide variety of signal-processing programs over several generations, it can justify a much greater investment in reliability testing.

⁹ Notice at para. 18.

¹⁰ Clearwire notes that the OSI model may not accurately describe the software partitioning described here, or the detailed specifics of the layers ultimately implemented in SDRs.

Clearwire agrees with Vanu that manufacturers should have the option of separating software into platform and signal-processing layers. Because the platform software controls all of the transmitter characteristics that most directly affect interference and RF safety, applicants should be required to test the hardware together with the platform software. The signal-processing software can safely be tested separately, and doing so will lower development costs.

2. Permissive change

Clearwire supports the Class III permissive change procedure outlined in the Notice.¹¹ As in the existing Class II permissive change process, the grantee should only have to submit a test report showing compliance with the technical rules and RF exposure limits for each operating mode.

We see no harm in permitting the original grantee to apply for simultaneous hardware and software changes. At the outset, however, hardware changes should be limited to the original grantee. Otherwise, third-party changes to the hardware could trigger unpredictable changes in the performance of the original grantee's software.

Similarly, if the initial radio is certified with separate platform and signal-processing software layers, then only the original grantee, or someone acting under its authority, should be permitted to apply for changes to the platform software. On the other hand, we see no harm in permitting any party to seek signal-processing software modifications (subject to intellectual property considerations). This would enable a service provider, for example, to download new

¹¹ Notice at paras. 25-27.

software to upgrade its services, without having to work through every manufacturer that might have supplied its customers.

3. Labeling

The Commission recognizes correctly that multiple software versions, developed and upgraded by multiple parties, could lead to confusion about which modes of operation are authorized for a specific radio.¹² But we do not believe the Commission's proposal for an electronic label displaying multiple FCC IDs is the best solution. A successful hardware platform may attract a large number of software versions. Worse, if the Commission permits certification with separate platform and signal-processing software, we expect the platform software will present a common software interface across multiple hardware platforms, greatly multiplying the number of signal-processing software versions that will execute on each type of hardware.

A better approach rests on a single FCC ID for each hardware implementation, tied to a publicly-available database that lists, for each FCC ID, (a) all of the software versions authorized for that radio, (b) the operating parameters for each version, and (c) the responsible party for each version.¹³ Either the Commission or an industry group could maintain this database.

If the Commission permits separate approval of platform and signal-processing software, as we urge above, then the FCC ID would identify a particular combination of hardware and

¹² Notice at para. 28.

¹³ See 47 C.F.R. Sec. 2.909 (responsible party).

platform software. The database link to that FCC ID would register all approved signal-processing software that runs on that particular hardware platform.

4. Other matters

Definition. Clearwire supports the proposed definition of SDRs.¹⁴

Software security. Clearwire agrees that the manufacturer must be responsible for ensuring that an unauthorized party cannot modify the software in ways that threaten to take the radio out of compliance.¹⁵ Clearwire has specific ideas on how this can be accomplished, and will present those later in the proceeding.

Copy of radio software. The Notice asks whether an applicant should be required to submit a copy of the radio software with the application.¹⁶ The intent is to ensure that a software executable is unchanged from the version deemed compliant. An applicant should be allowed to submit either a copy of the compliant executable, or a version number and unique identifier, such as a checksum, that guarantees the software to be the intended version.

Limit on hardware/software combinations. The Notice asks whether the Commission should place limits on the number of hardware and software combinations under a single approval.¹⁷ Such a provision is not only unnecessary, but would at least partially defeat the benefits of SDR authorization. As noted, a popular and flexible hardware platform may attract a

¹⁴ Notice at para. 21.

¹⁵ Notice at para. 31.

¹⁶ Notice at para. 28.

¹⁷ Notice at para. 28.

large number of software packages, and in doing so will further the Commission's policy goals. Moreover, the FCC ID database proposed above would obviate any practical need for such a limit.

Measurement method. Clearwire agrees with the Commission's tentative conclusion that there is no need to change the present method of measurement.¹⁸

CONCLUSION

Software-defined radios show great promise for improving spectrum efficiency, speeding innovation, facilitating universal roaming, and giving the Commission new flexibility in spectrum allocations.

Clearwire generally supports the Commission's proposed rules. However, Clearwire agrees with Vanu, Inc. that the Commission should recognize a distinction between platform software and signal-processing software. Applicants should be required to test platform software with the hardware, but should be permitted to test signal-processing software separately.

¹⁸ Notice at para. 32.

Clearwire urges a speedy resolution to this proceeding, and is prepared to manufacture SDRs for fixed applications as soon as the Commission has rules in place.

Respectfully submitted,

/s/

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